Soil Monitoring

Fenny van Egmond

Wageningen, WICC, 4 december 2024

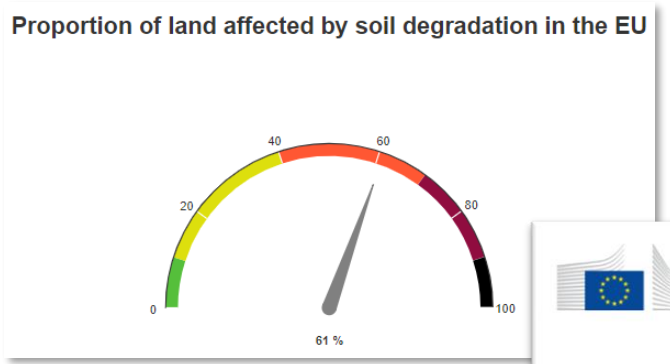
EJP SOIL
European Joint Programme

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

Uitdagingen mbt bodem die data nodig hebben

In Nederland en in Europa:

- Voedselzekerheid
- Waterberging
- Landinrichting
- Biodiversiteit
- Klimaatverandering




EUROPEAN COMMISSION

Brussels, 5.7.2023
COM(2023) 416 final

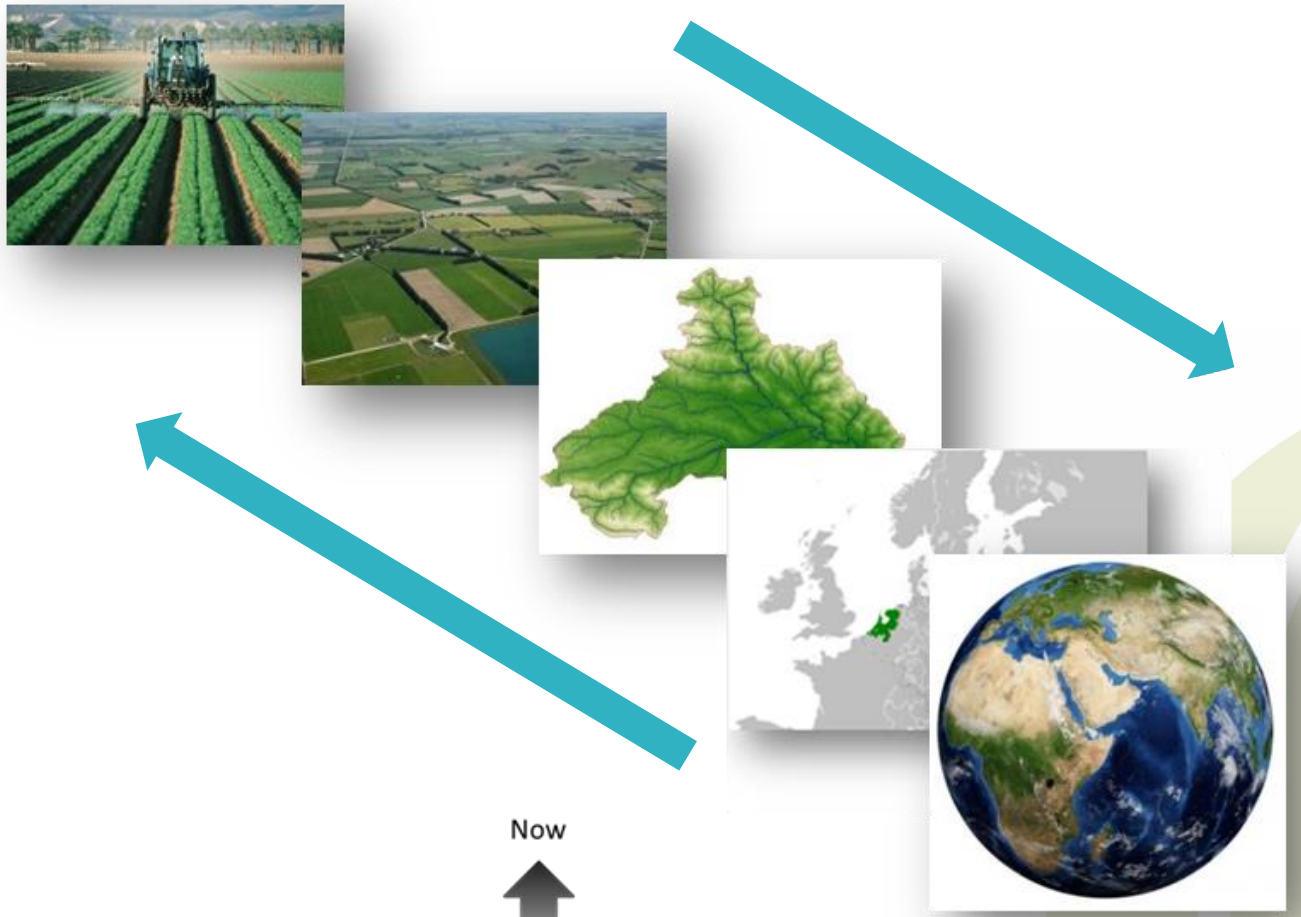
2023/0232 (COD)

Proposal for a

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

on Soil Monitoring and Resilience (Soil Monitoring Law)

{SEC(2023) 416 final} - {SWD(2023) 416 final} - {SWD(2023) 417 final} - {SWD(2023) 418 final} - {SWD(2023) 423 final}



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Status quo van bodem(monitorings)data

In Nederland en Europa

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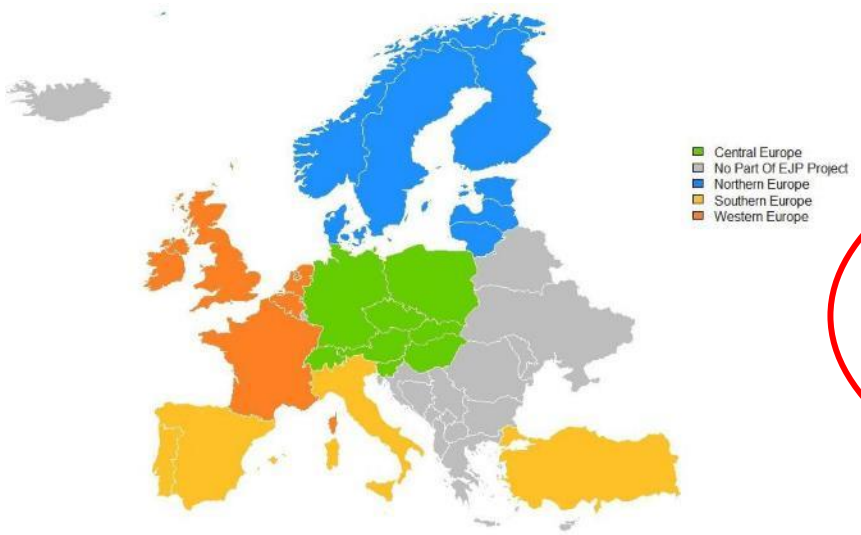
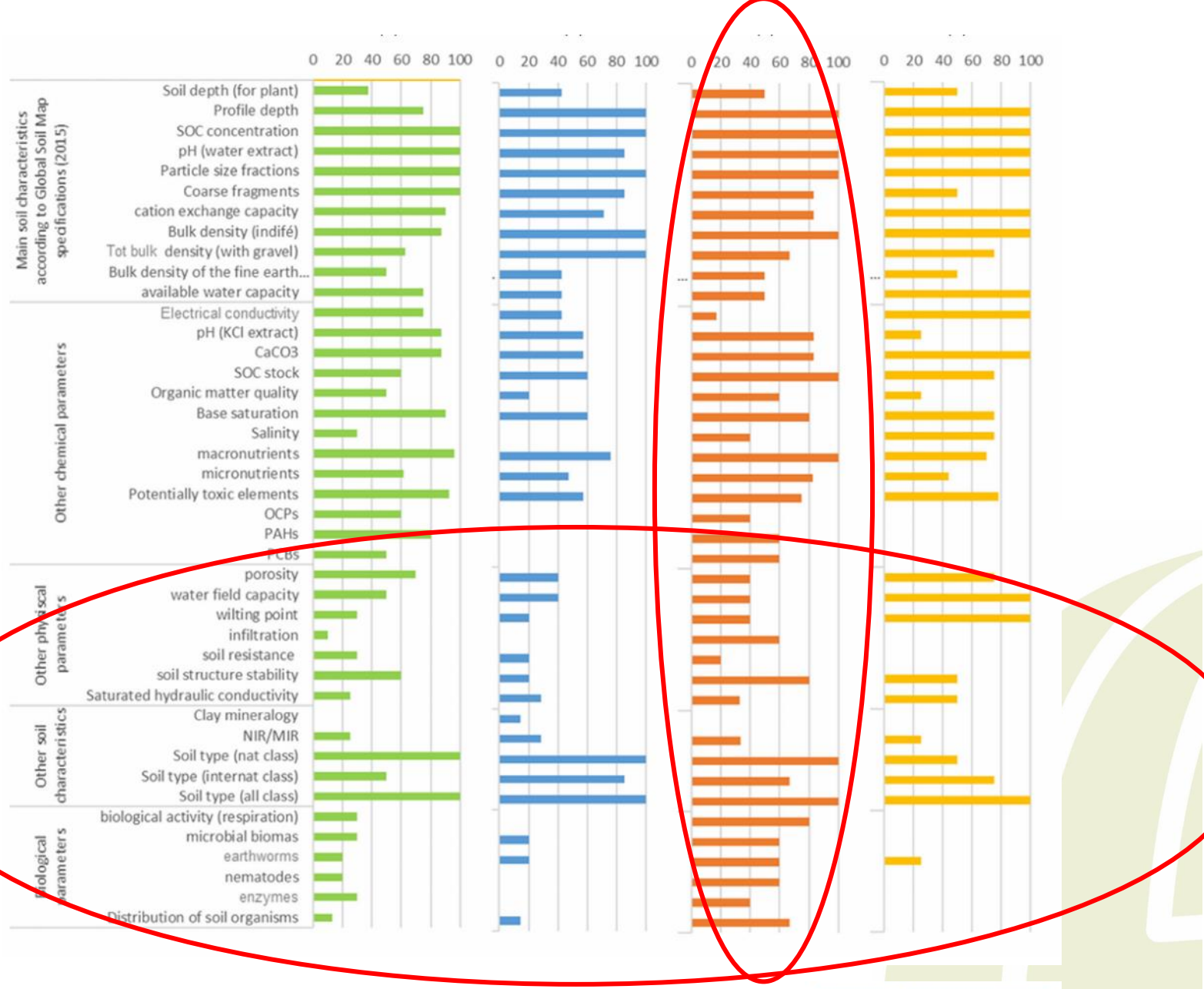
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

Stocktake: Nationale bodemdata in EU landen: Waar staan we ?

Data beschikbaarheid in verschillende Europese regio's (% van de landen)





Cornu et al. 2023. EJSS. https://doi.org/10.1111/ejss.13398

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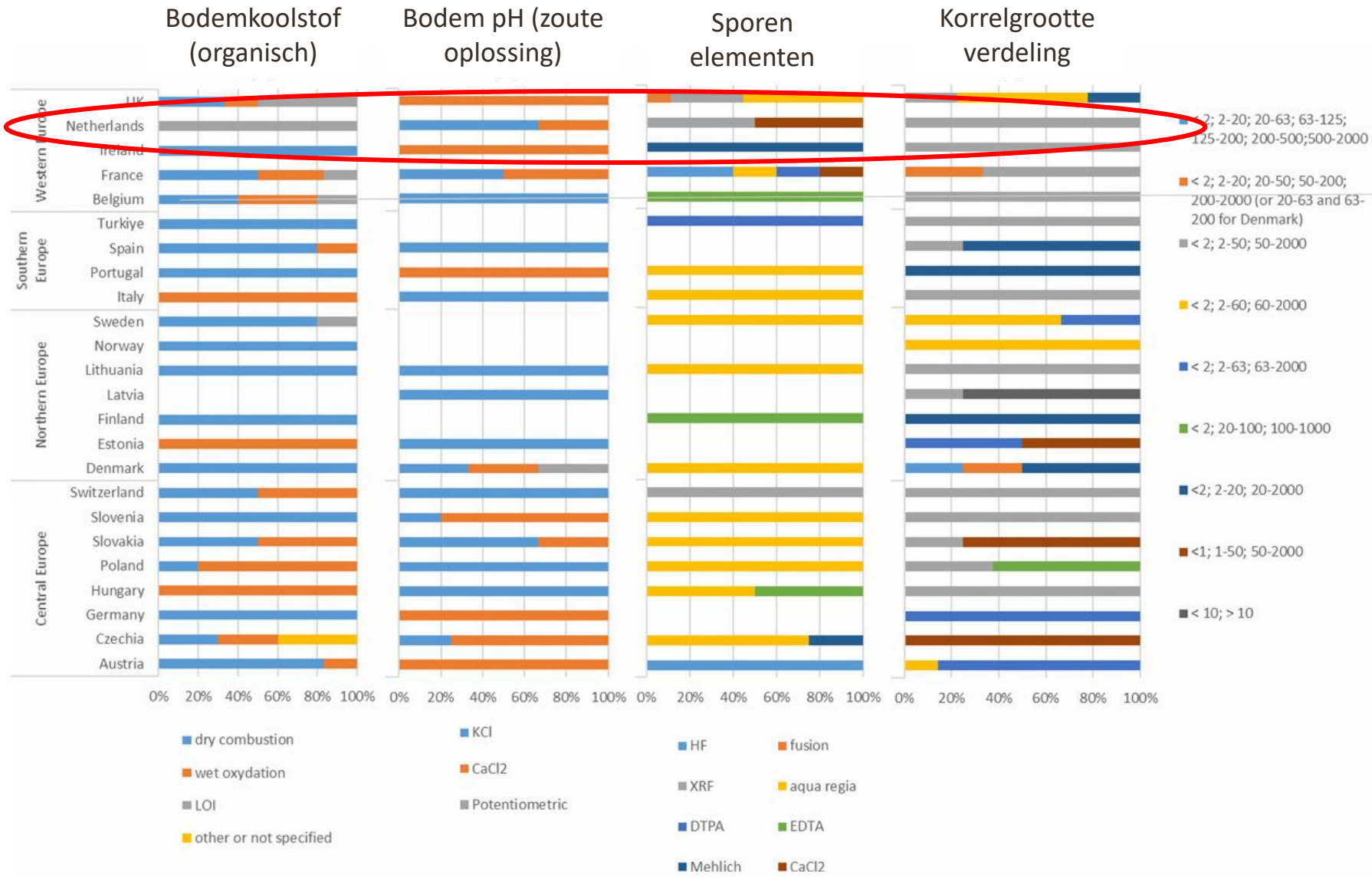
European Journal of Soil Science

Variatie in gebruikte lab methoden in Europese landen



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European Journal of Soil Science

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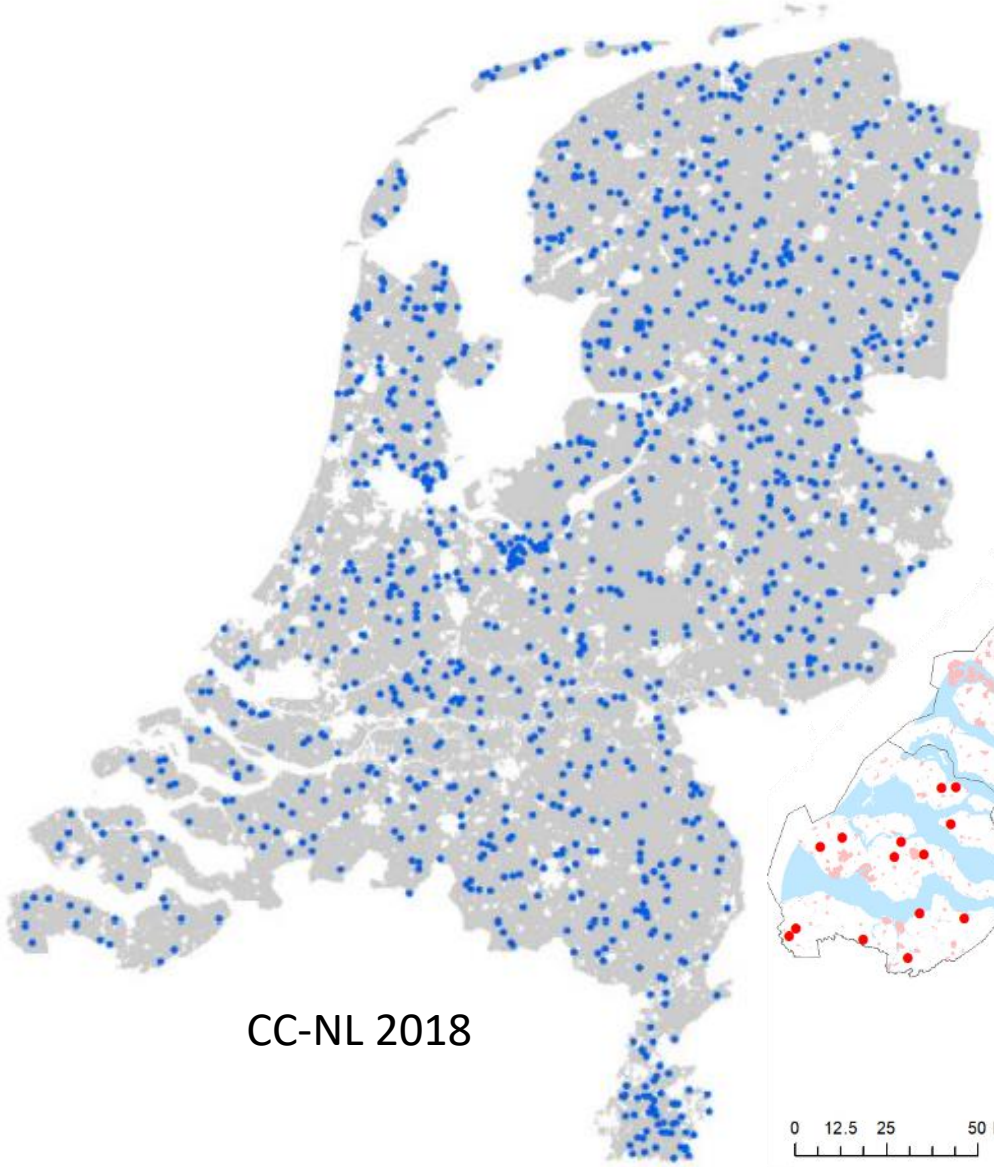
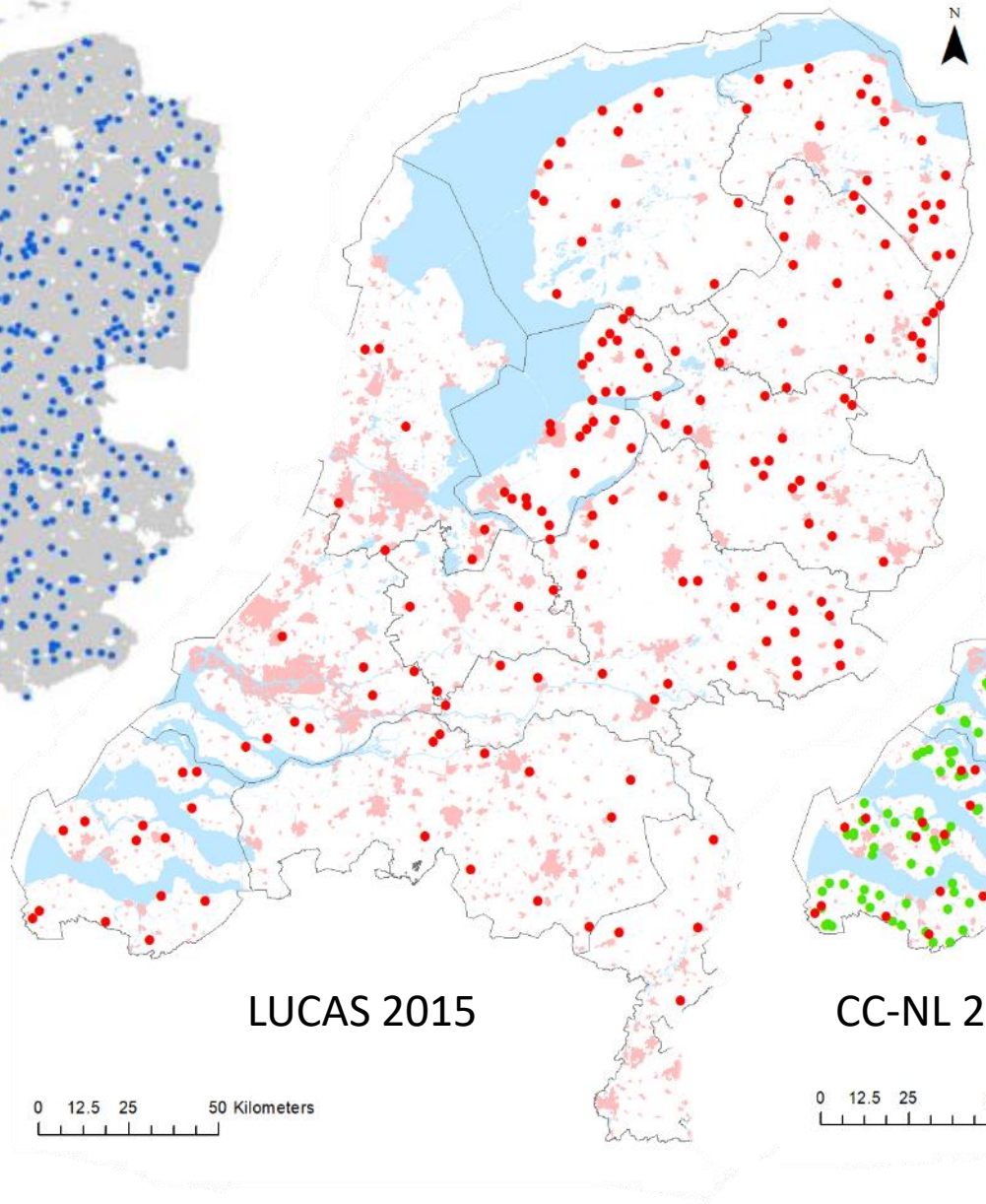
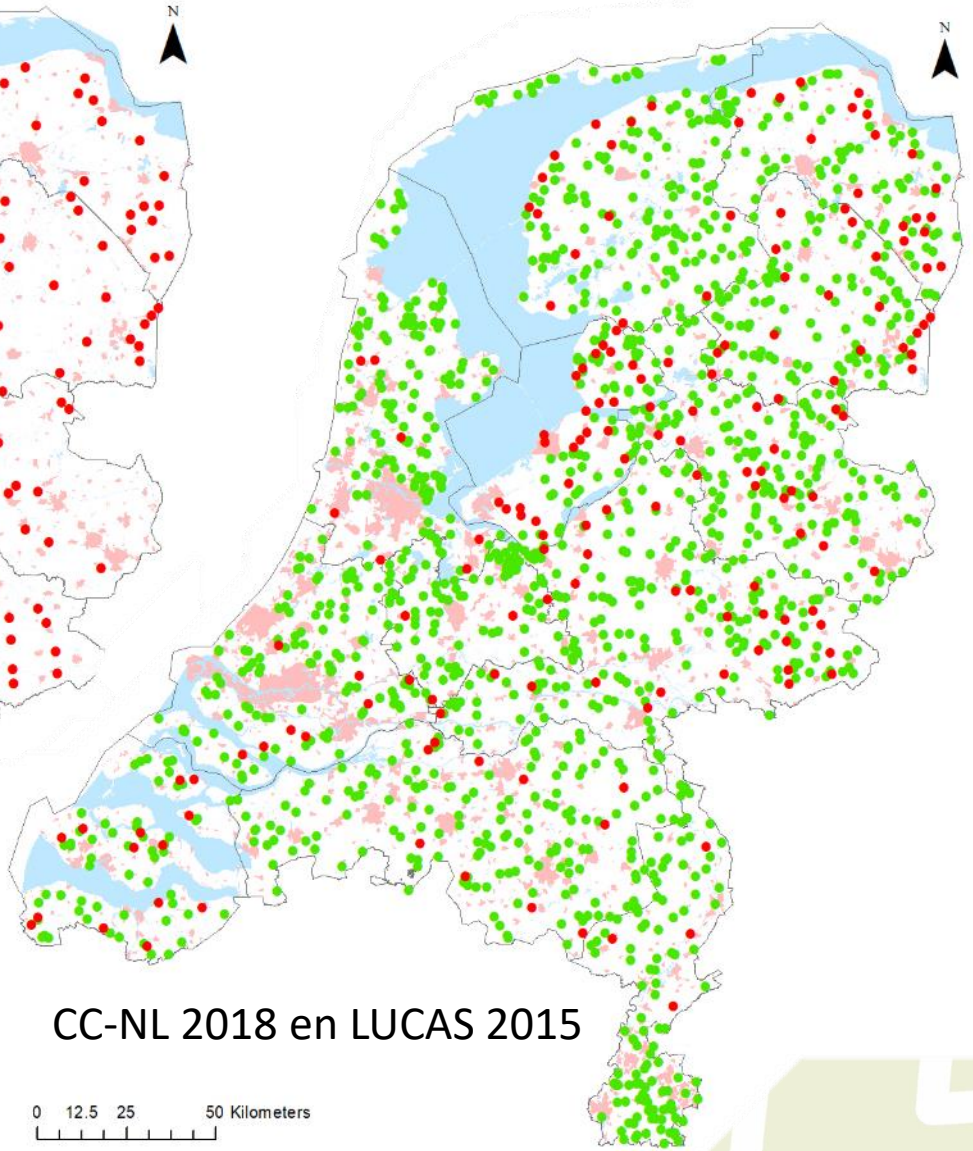


CC-NL 2018



LUCAS 2015



CC-NL 2018 en LUCAS 2015

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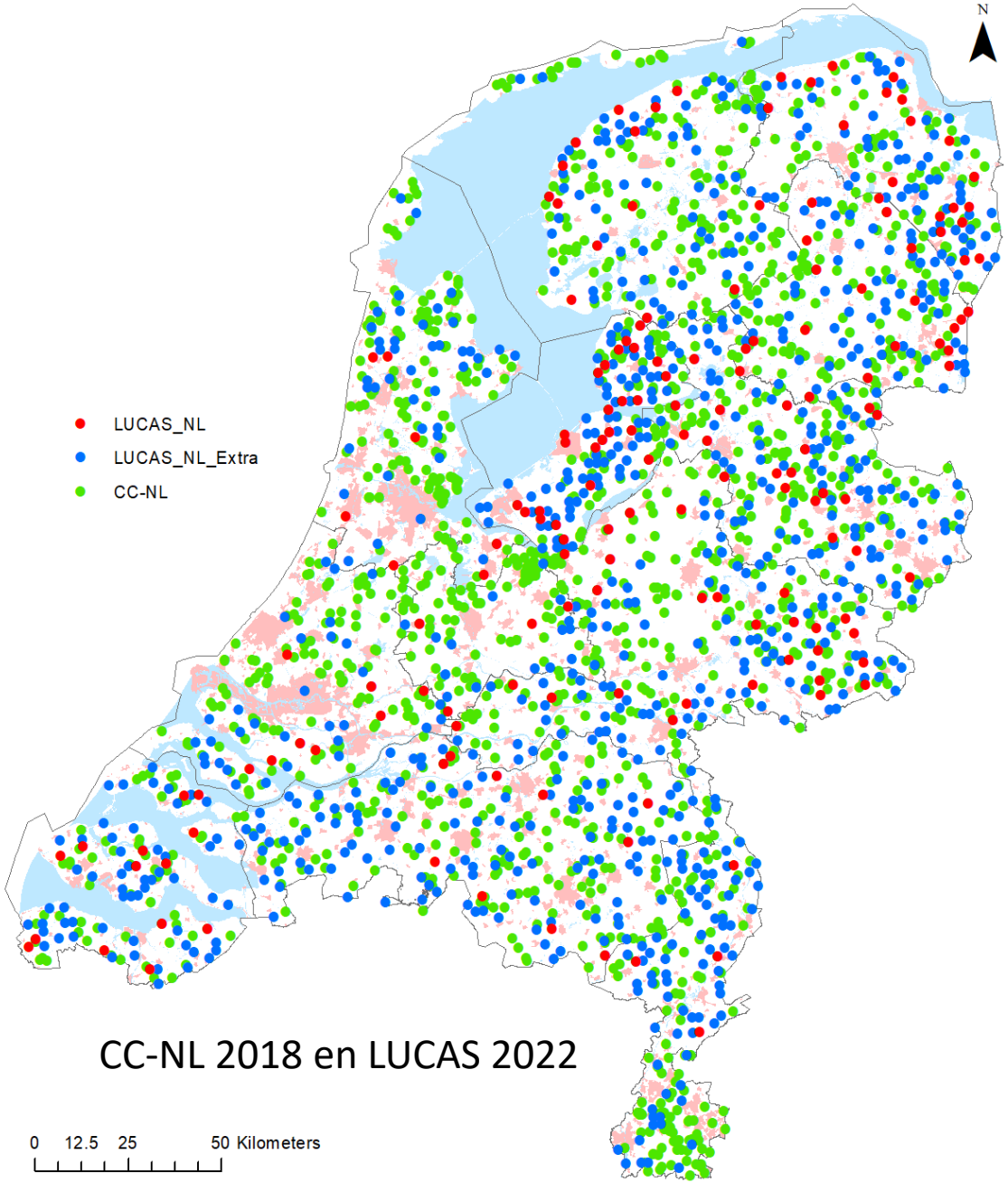
Waar meten we wat en hoe? (met welk doel)



CC-NL 2018 en LUCAS 2022

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Uitdagingen en mogelijke oplossingsrichtingen

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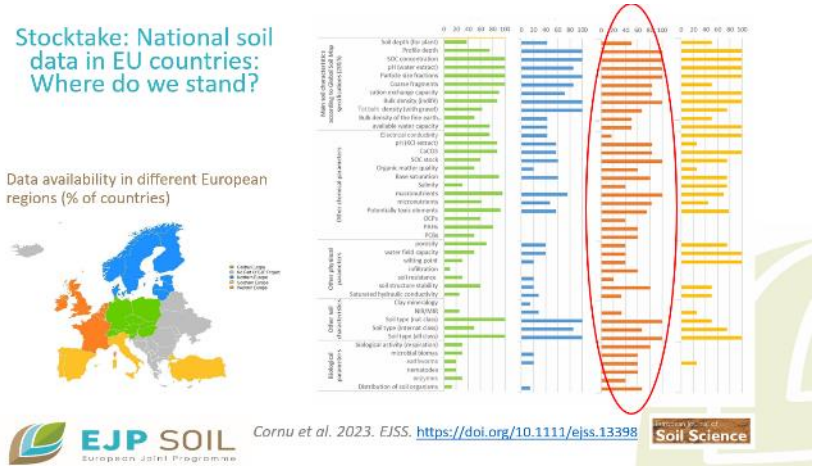
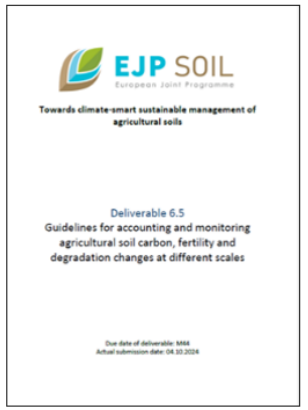
Uitdagingen: Waar, wat, wanneer, hoe meten voor wie, waarvoor?



EJP SOIL proposed indicators *vs* SML

	Agreement	Changes suggested
SOC	•SOC Content •SOC Stock	•Delete: SOC/clay •Add: SOC/SOCexp and SOC/SOCmax
Soil nutrients	Total N, Extractable P	Add : P stocks (not only available P) and C/N ratio (N potential delivery)
CEC		CEC and ESP to be added
pH	pH in Water	
Electrical conductivity	Electr. Conductivity	
Available water capacity		Infiltration rate, permeability along the soil profile and/or the soil porosity
Soil biodiversity	Biodiversity (since last version of SML)	Biodiversity (functional and structural indicators)
Soil structure	Bulk density	
Soil contamination	Trace elements and selected organics	
Soil sealing	Soil sealing	
Soil erosion	Soil loss rate	



For each indicator:

1. **Why to measure ?**
2. **How to measure ?**
3. **Do we have existing thresholds?**
4. **Main recommendations**

And **comprehensive annexes reviewing the state of the art**

EJP SOIL A. Bispo et al. Deliverable D6.5, 2024 … under approval by REA

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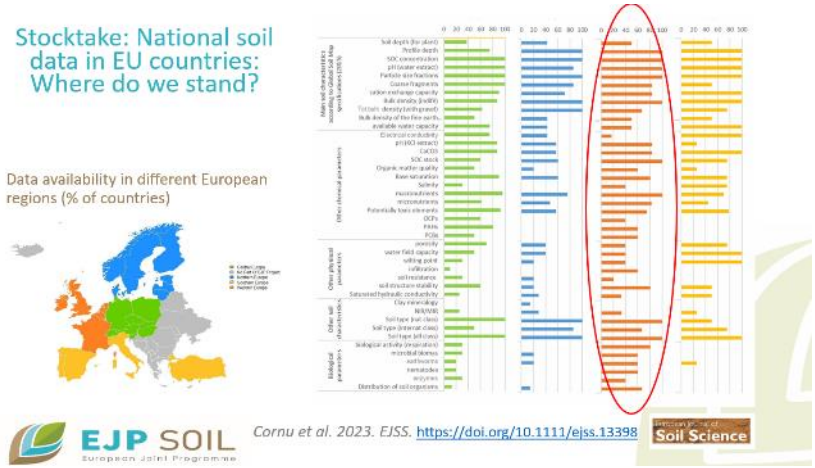
Uitdagingen: Waar, wat, wanneer, hoe meten voor wie, waarvoor?



Suggested set of biological indicators

EJP SOIL MINOTAUR

Minimum set of indicators to be used (less than 1,000 euros/sample)

Priority level	Recommended indicators		Brief description	Methodology	Cost
Tier I	Functional Indicators	Microbial biomass C	Amount of microbial biomass per gram soil	ISO 14 240-1 / -2 EN ISO 11 063	20-30€/sample
		Microbial respiration	Production of CO2 per amount of soil	ISO 16072:2002	20-30€/sample
		Enzyme activity	Measurement of several hydrolase activities in soil	ISO 14 238 ISO/TS 22 939 ISO 23 753-1 ISO 23 753-2	20-80€ for each enzyme
	Structural indicators	Ecosystem engineers (Macrofauna)	Structural and functional diversity (earthworms)	ISO 23611-1:2018	30-140€
		Biological regulators (Mesofauna)	Structural and functional diversity	ISO 23611-2:2006 QBS-ar (Parisi et al., 2005)	75-140€
		Biological regulators (Microfauna)	Structural and functional diversity (nematodes)	ISO 23611-4:2006	30-140€
		Chemical engineers (Microorganisms)	Structural diversity of soil microbiota (bacteria, archaea, fungi)	DNA metabarcoding (ISO 11063:2020) and Plassart et al., 2012	75-100€ for each target group

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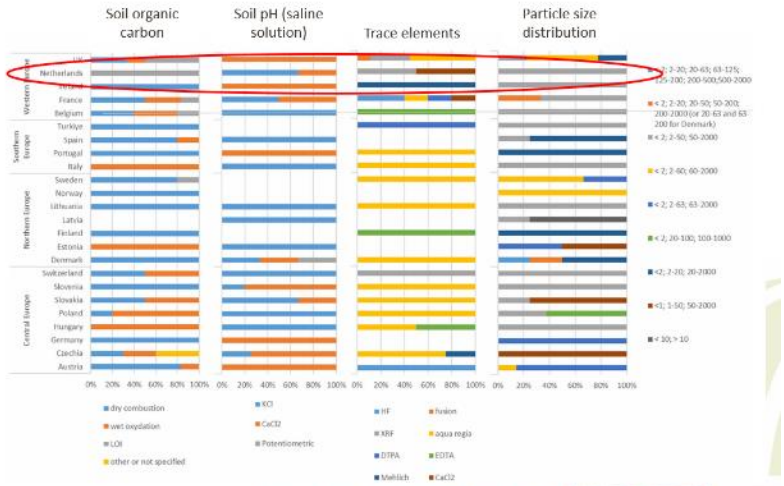
Lab methoden omrekenen: transfer functies

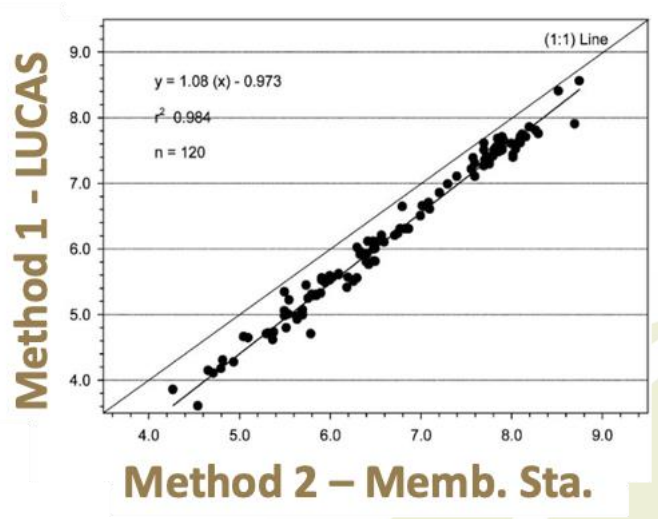
Variability of laboratory methods used in European countries



Cornu et al. 2023. EJSS. https://doi.org/10.1111/ejss.13398

Double sampling exercise binnen LUCAS Soil 2022 om de impact van het gebruik van verschillende bemonsterin gsprotocollen en lab methoden te kunnen bepalen en transfer functies te kunnen afleiden (17 landen)

Transfer functions



Loopt nog; wordt afgerond na de looptijd van EJP SOIL.

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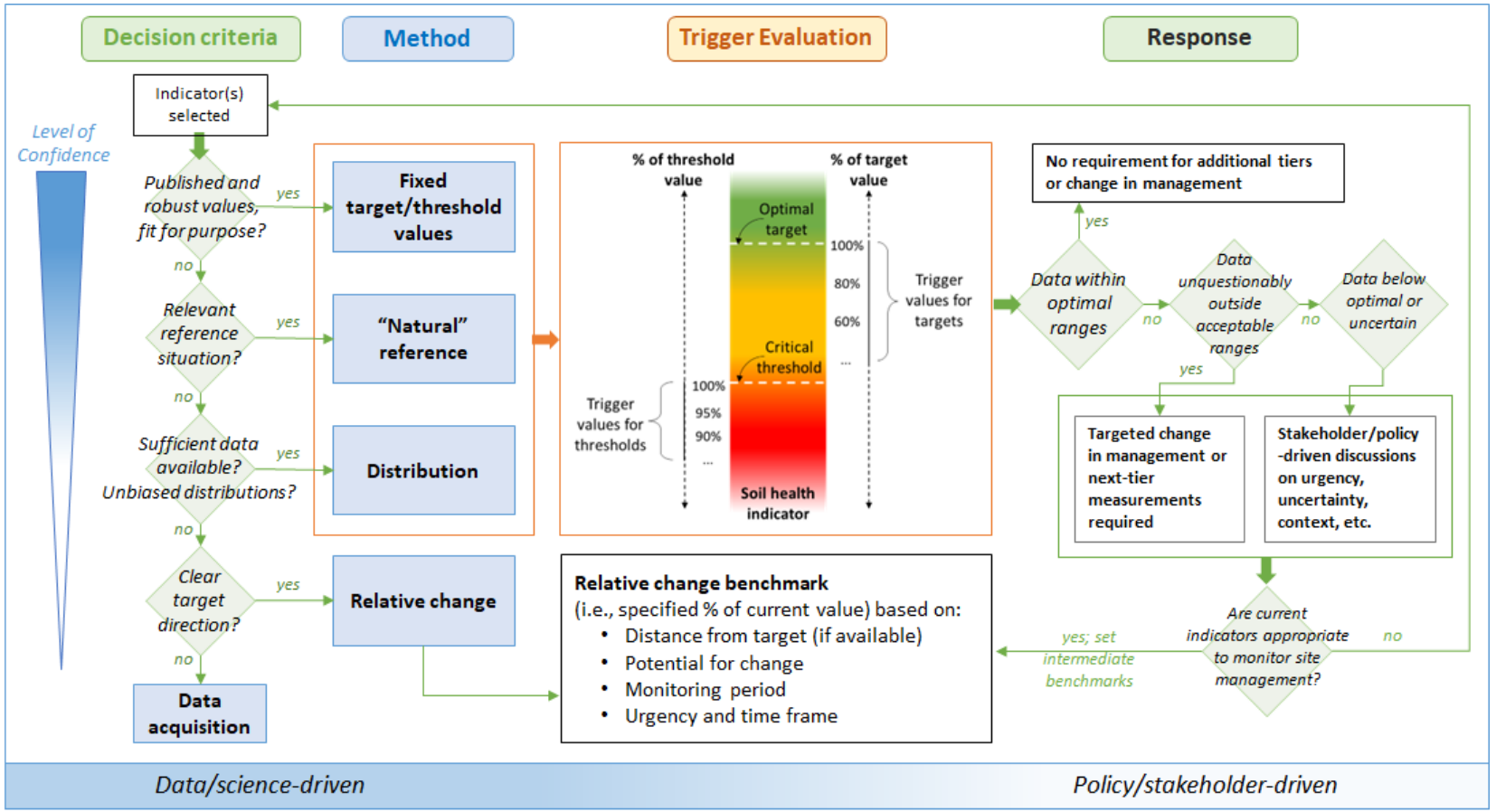
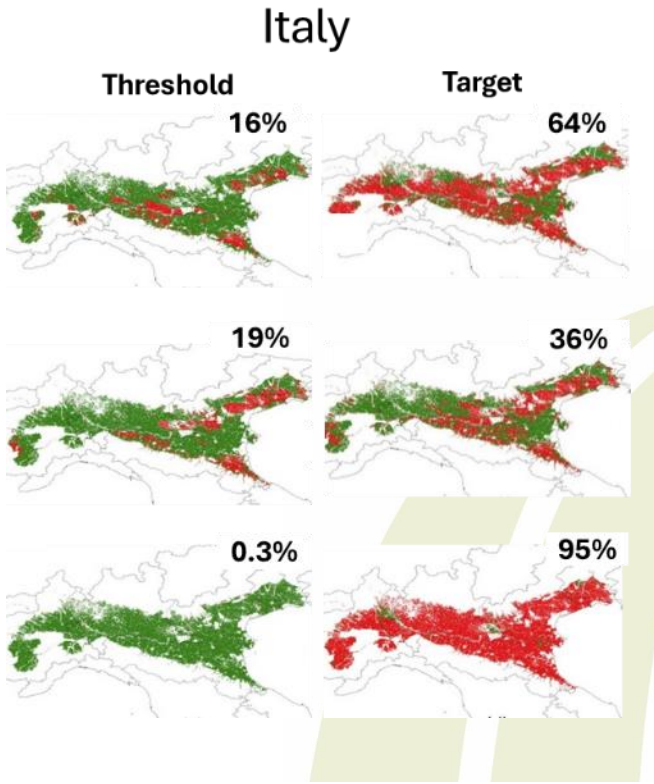
Evaluatie methoden resultaten indicatoren

De concepten operational trigger values en target values zijn opgenomen in het SML rev II voorstel.





Matson et al. 2024, Four approaches to setting soil health targets and thresholds in agricultural soils, https://doi.org/10.1016/j.jenvman.2024.123141

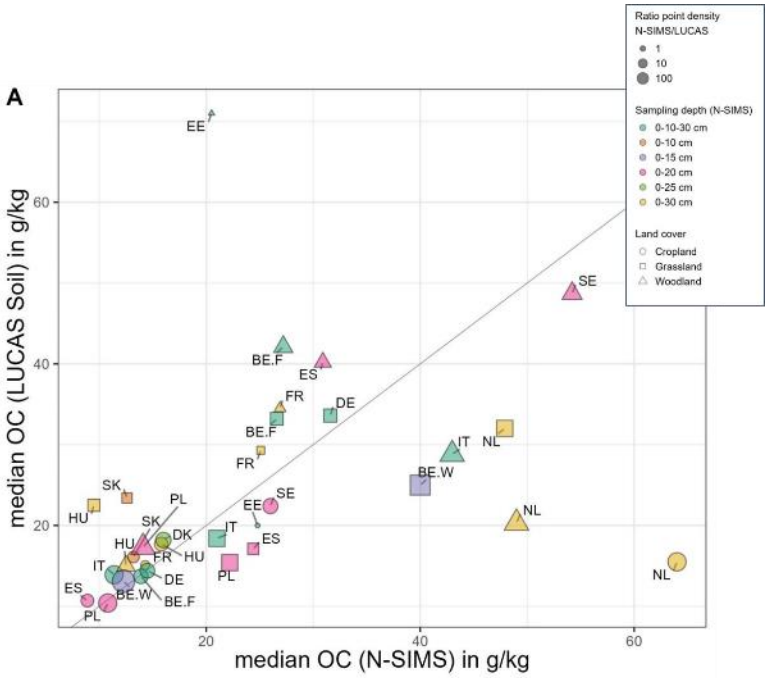
Distribution : Threshold = 12.5% and Target = 87.5%

Reference : Target : 80% of SOC permanent grassland
Threshold: 60% of SOC permanent grassland

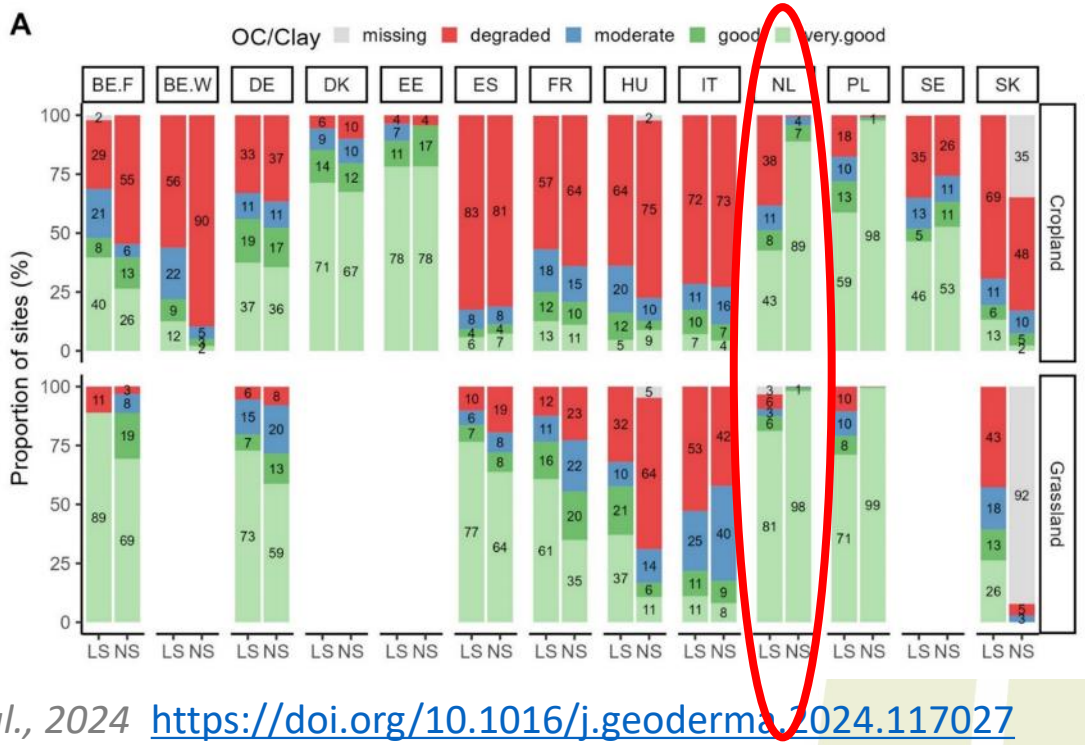
Vergelijk van nationale en LUCAS Soil datasets in 12 EU lidstaten

- De ruimtelijke verdeling van bemonsteringslocaties verschilt, wat leidt tot een over- of onderbemonstering van een aantal bodemtypen en landgebruiken
- Significante verschillen in of statistische verdeling van bodemeigenschappen, afhankelijk van de gebruikte monitoringsdataset (LUCAS Soil of Nationaal bodemmonitoringssysteem)
  - Combineren van datasets is daarom gecompliceerd
  - Van invloed op de bodemgezongheidsbeoordeling

LUCAS

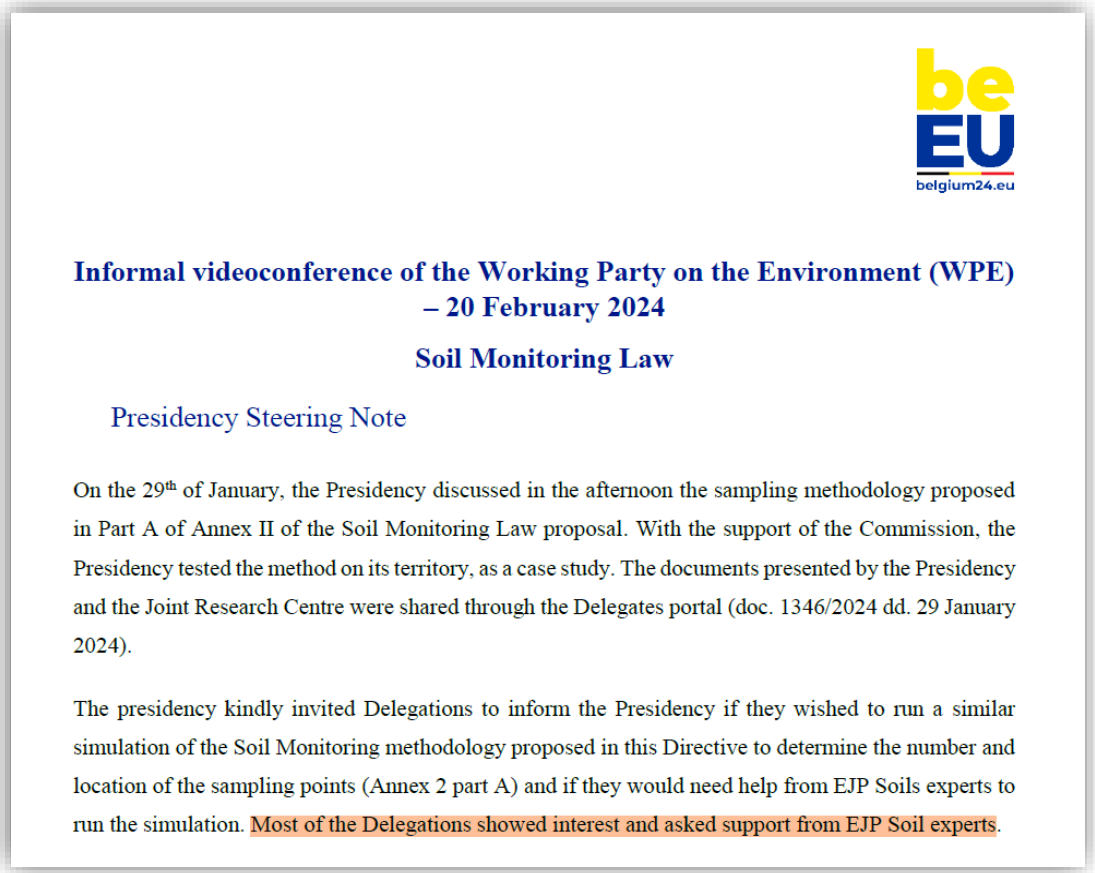


Nationaal



Froger et al., 2024 https://doi.org/10.1016/j.geoderma.2024.117027

Task force EJP SOIL: helpen van lidstaten met eerste doorrekening voorgestelde SML bemonsteringsontwerp



Informal videoconference of the Working Party on the Environment (WPE) – 20 February 2024

Soil Monitoring Law

Presidency Steering Note

On the 29th of January, the Presidency discussed in the afternoon the sampling methodology proposed in Part A of Annex II of the Soil Monitoring Law proposal. With the support of the Commission, the Presidency tested the method on its territory, as a case study. The documents presented by the Presidency and the Joint Research Centre were shared through the Delegates portal (doc. 1346/2024 dd. 29 January 2024).

The presidency kindly invited Delegations to inform the Presidency if they wished to run a similar simulation of the Soil Monitoring methodology proposed in this Directive to determine the number and location of the sampling points (Annex 2 part A) and if they would need help from EJP Soils experts to run the simulation. Most of the Delegations showed interest and asked support from EJP Soil experts.

- Doel SML: harmoniseren bodemmonitoring in EU
  - ✓ Met behoud van bestaande bodemmonitoringssystemen en LUCAS
- Doel oefening: testen van de voorgestelde methode
  - ✓Wetenschappelijk correct
  - ✓Medeneming van bestaande systemen gewaarborgd
  - ✓Doorrekenen scenario's door lidstaten (aantal districten, punten, meetdichtheid, bestaande systemen)
- Resultaat:
  - ✓Aangepaste testmethode, verder te verbeteren voor gebruik tijdens implementatie
  - ✓Aangepaste wettekst
  - ✓Toevoegen van soil units binnen soil districts
  - ✓Goede en snelle samenwerking tussen 24 lidstaten, tussen instituten en ministeries in lidstaten, tussen DG ENV, JRC, instituten, ministeries

Betere uitwerking nodig in implementatie fase

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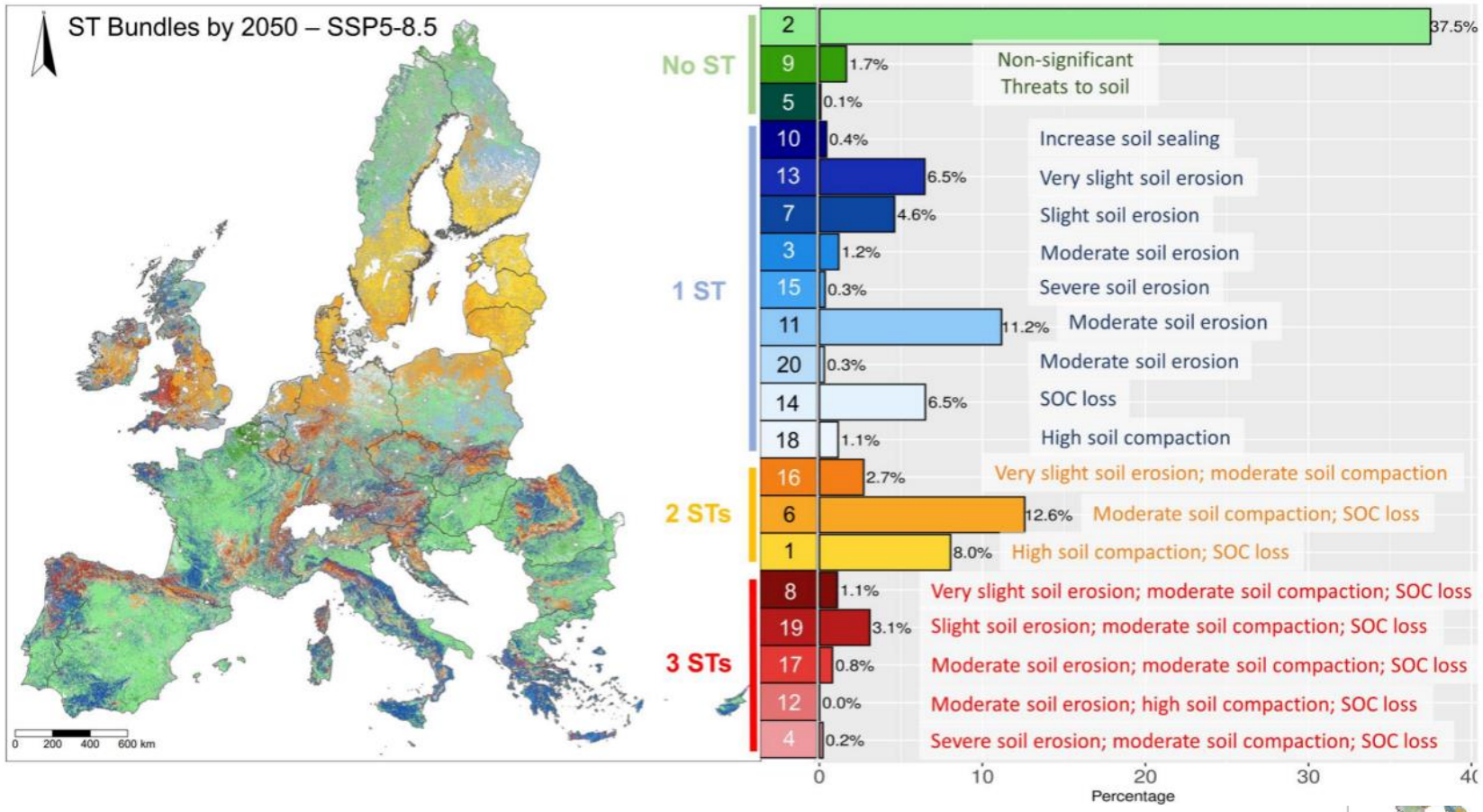
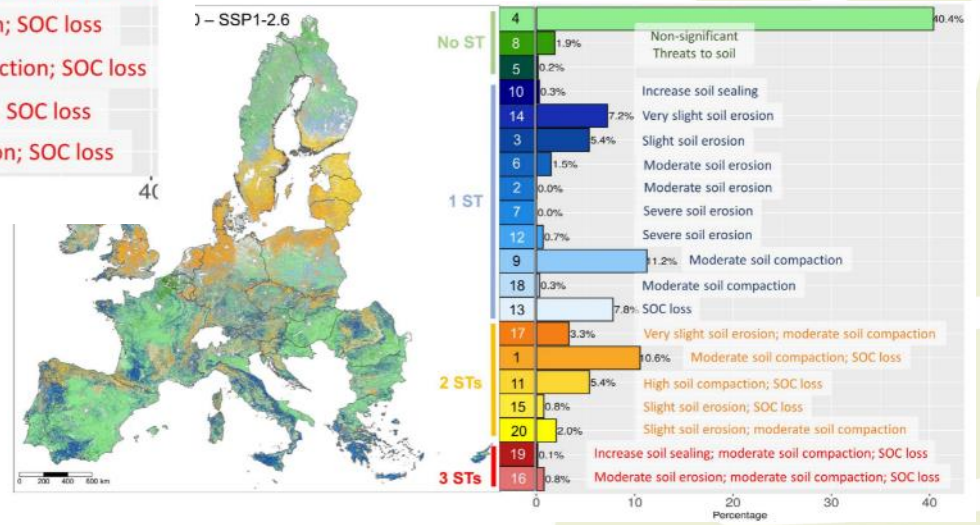
Assessment of a projected bundle of Soil Threats at EU level by using scenarios (land use and climate)



Bundle:

- **SEALING**
- **EROSION**
- **COMPACTION**
- **SOC LOSS**



Land use change scenario: **LUISA**

Climate change scenarios: **SSP5-8.5 (fossil fuel-rich development) / SSP1-2.6 (sustainable pathways)**

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Meettechnieken - Sensing

Remote en Proximal

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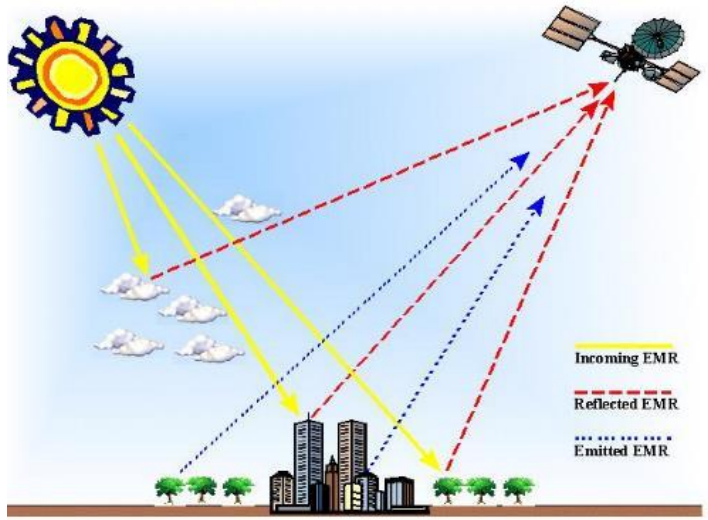
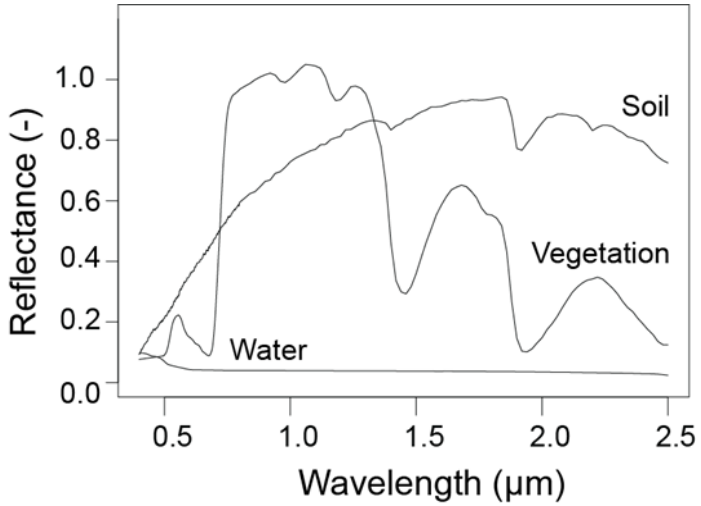
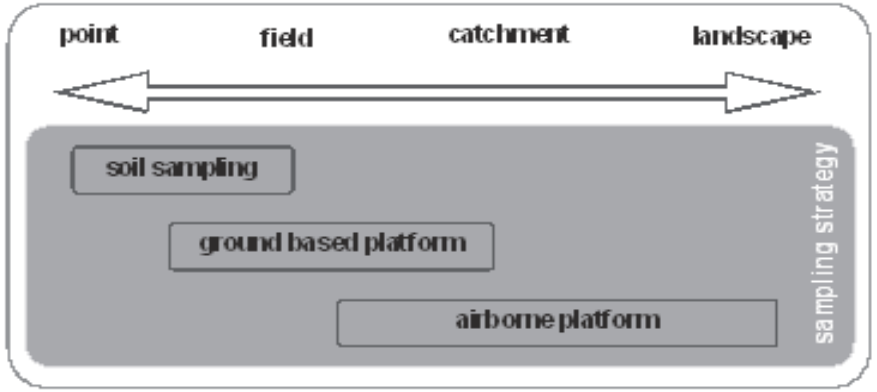
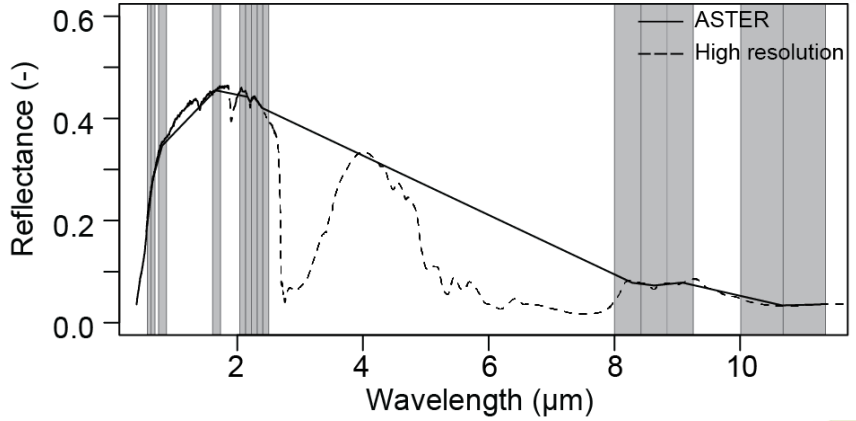
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.

Satelliet en proximal soil sensing









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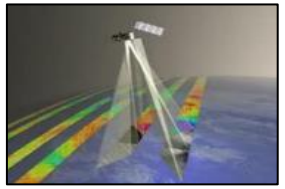
Voordelen

- **Kosteneffectief** (SOC spectraal lab: ~ 1/3 van conventionele lab kosten)
- **Veel bodemeigenschappen tegelijk**: Textuur, SOC, TC, TN, pH, CEC, plantbeschikbaar Ca, P sorptie, een aantal nutriënten
- **Snel, non-destructief, reproduceerbaar**
- **Verschillende platforms mogelijk**: lab, veld, remote
- **Groot bereik, redelijke resolutie, patronen, kaarten**
- **Protocollen in ontwikkeling** door de (wetenschappelijke) gemeenschap

Nadelen

- **Wolken/vegetatiebedekking**
- In veld/remote: **ruis** vanwege vocht, ruwheid, droge vegetatie, hoge zoutgehalten
- **< 1 cm signaal indringing**
- **Indirect**: kalibratie modellen nodig
- **Nauwkeurigheid**: lab>veld>UAV>Satelliet en hyperspectraal>multispectraal
- **Model kwaliteit wisselt** per eigenschap en is afhankelijk van beschikbare modellen en data (spectral library)
- **Niet nauwkeurig genoeg afhankelijk van de toepassing**



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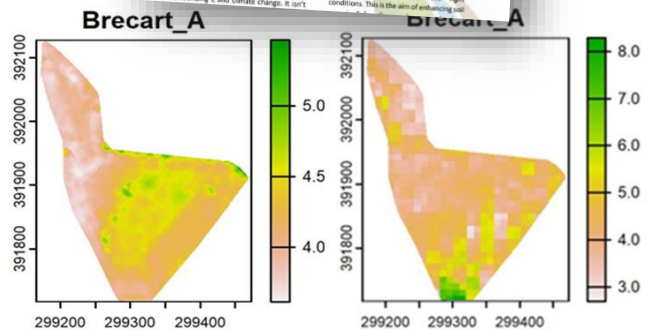
Overzicht resultaten EJP SOIL op sensing

- **Verbetering methode** bodem remote sensing: haalbaarheid van correctiefactoren voor verstoringen
- **Vochtcorrectie** voor remote en proximal sensing ontwikkeld en getest: rekenkundig en veldprotocol
- Evaluatie van **kosten/nauwkeurigheid** voor interpolatietechnieken, en gebruik van satelliet of proximal soil sensors: Literatuuronderzoek en testen op diverse velden in de EU, incl. decision tree
- **Extrapolatie** van kalibratiemodellen werkt op regionale schaal, afhankelijk van de input

Baseline	Mean prediction	RMSE / SD
	Northern field	
Averaging	4.18	0.58
Simple interpolation	4.20	058
DSM (best model)	4.41	0.72



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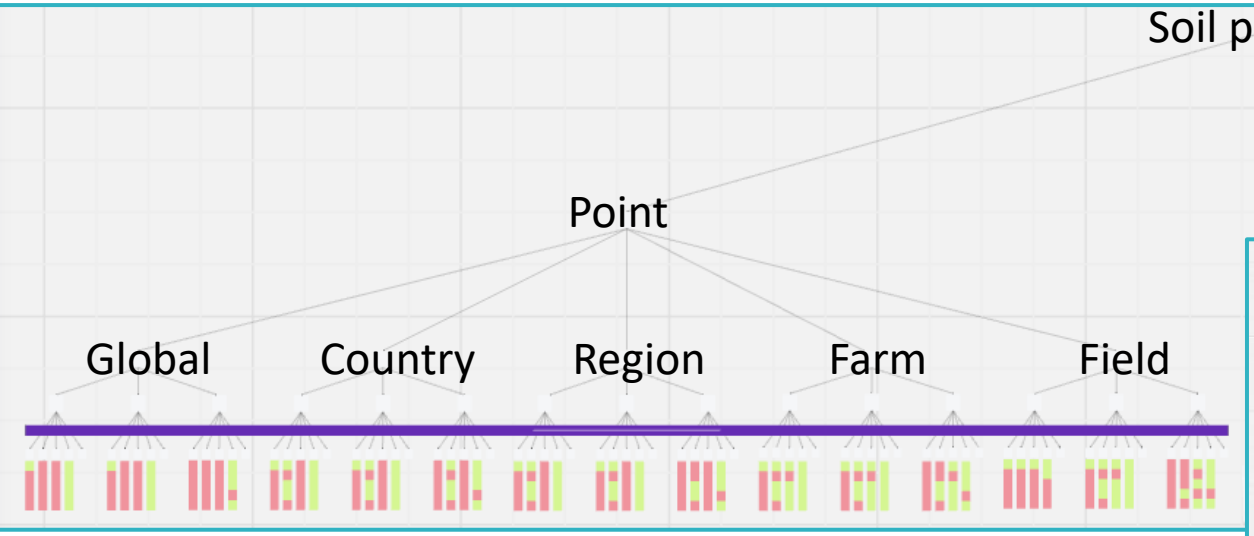
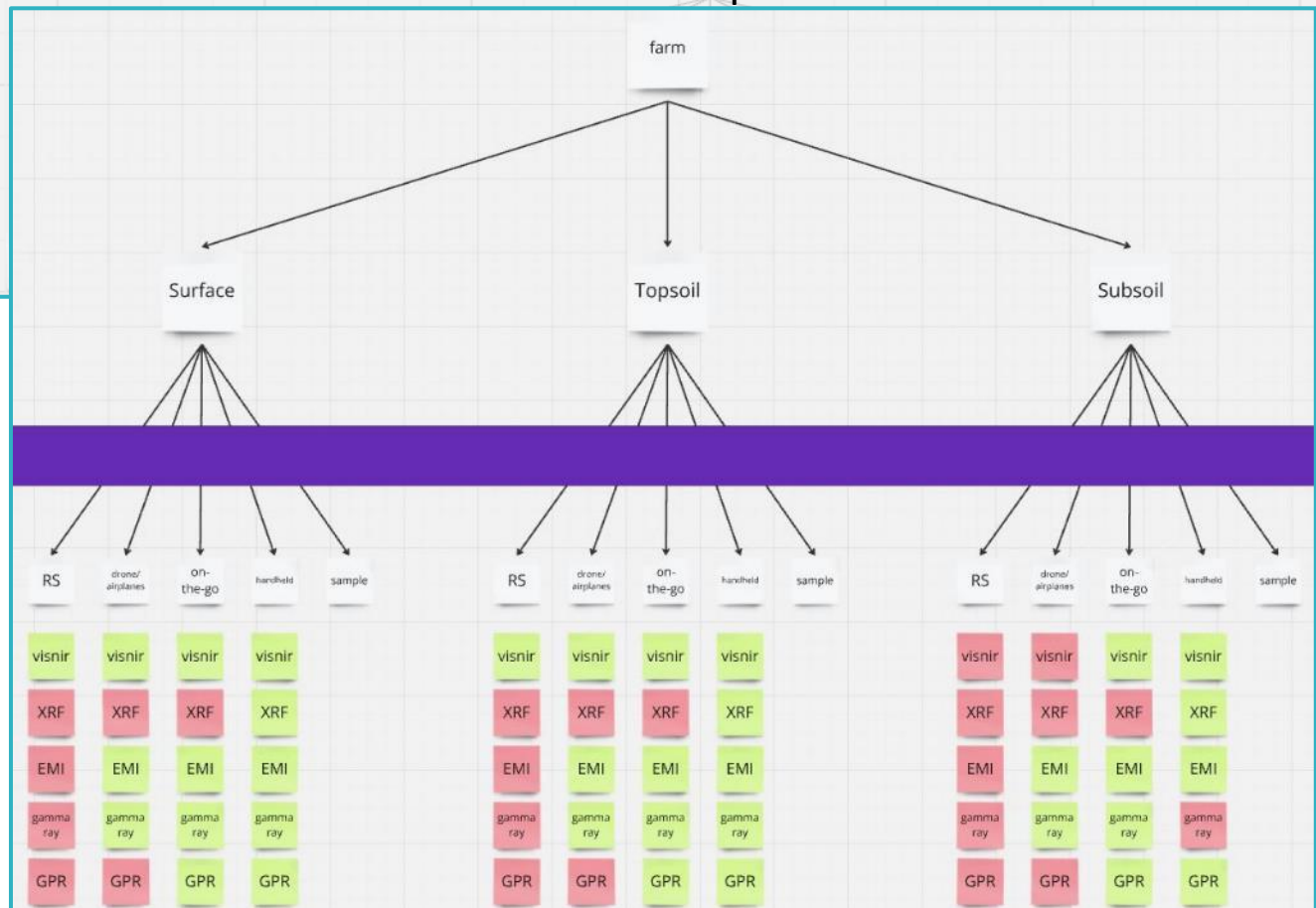
Eerste versie van een beslisboom voor (sensing) meettechnieken





SOC - VNIR	
NRMSE_avg	0.107
NRMSE_sd	0.094
N	219
Cost	$$$ per unit
TRL	x/y
Trustworthiness of machine	v/w

Other parameters	
Clay	0.151(0.140), n = 44
...	...
protocol	link

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Resultaten remote en proximal sensing mogeljkheden (VNIR):

Geschikt

- Vegetatie patronen en identificatie
- Biomassa schattingen
- Digitale bodemkartering (DSM) op verschillende schalen
- Slim bemonsteren
- Patronen binnen velden
- Grotere verschillen in bodem eigenschappen
- Land management detectie: ploegen

Ongeschikt

- Directe schatting van bodemeigenschappen (met grote nauwkeurigheid)
- Precieze kwantitatieve schatting
- Detectie van bodemkoolstofveranderingen
- Brede land management maatregelen detectie

EU Soil Monitoring Directive

EU Carbon Removals and Carbon Farming framework

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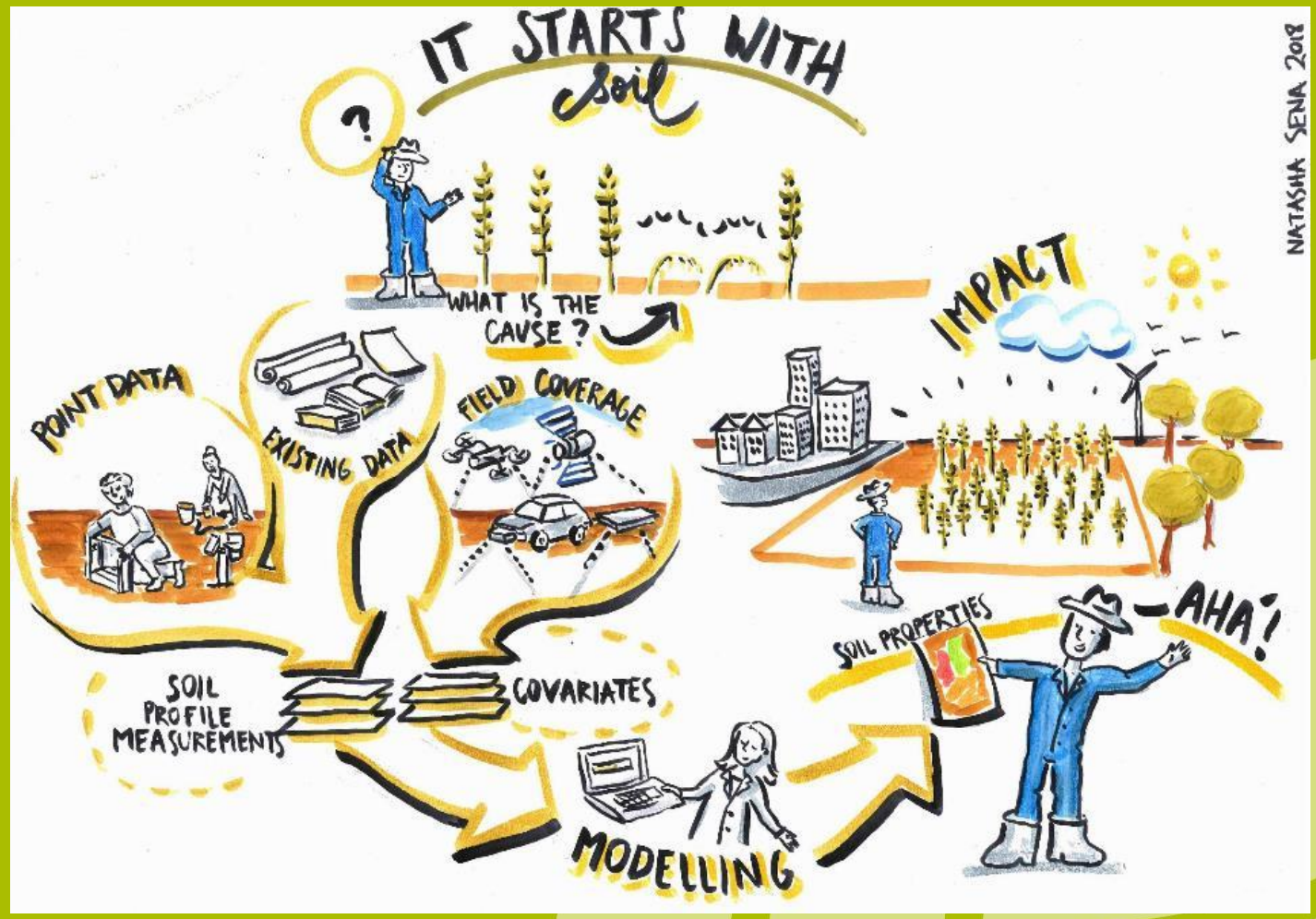
Bedankt voor de aandacht!



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